Space Weather Technical Forecast

Issued on Monday 28 October 2024 at 13:15 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: S2 Moderate Solar Radiation Storm ongoing. Further M-class flares expected with chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with peak flare M2.8 at 27/2324 UTC from AR3878 in the northeast. This is a relatively small but complex region that is now showing a small but strong delta spot on its trailer. There are eleven sunspot regions on the disc, and the most likely source of further notable flares is the congested southeast disc with a number of regions. AR3872 has a delta configuration with some ongoing slight growth, and is flanked on either side by AR3873 and AR3869. Although these two nearby spots have shown a declining trend. AR3876 in the south-centre and AR3874 in the northwest, while simpler, have both shown some slow development in the last 24 hours.

No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The anticipated X1.8 flare CME, which left the Sun on 26 Oct, arrived at L1 at 18/0414 UTC. This was followed by solar winds speeds, observed by ACE, increasing from Slightly Elevated at 400km/s to be Elevated at near 600km/s. These winds then eased to around 500km/s by the end of the period. Density was at or near average for much of the period, but became above average for a time around 27/0400-0800 UTC. Interplanetary Magnetic Field (IMF), Bt, was initially Weak at 5-8nT, then rose sharply to be Strong at around 22nT with the CME arrival, then eased to be Moderate at 10nT by the end of the period. The north-south component, Bz, was variable and weak for much of the period, but also became strong for a time with the CME arrival, varying +/-20nT, but favoured a positive (northward) orientation. Phi angle remained negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp2-3) but became Active to G1 Minor Storm (Kp4-5) for a time with the CME arrival 28/0300-0900 UTC.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 persisted at S2 Moderate Storm, with peak 356 pfu at 28/1020 UTC. High energy electron flux (greater than 2MeV) observed by GOES16 was at background. The associated 24-hour fluence was well below the Active threshold, with 1.57e6 integrated flux observed at 28/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected, with further M-class flares expected and a chance of isolated X-class flares.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

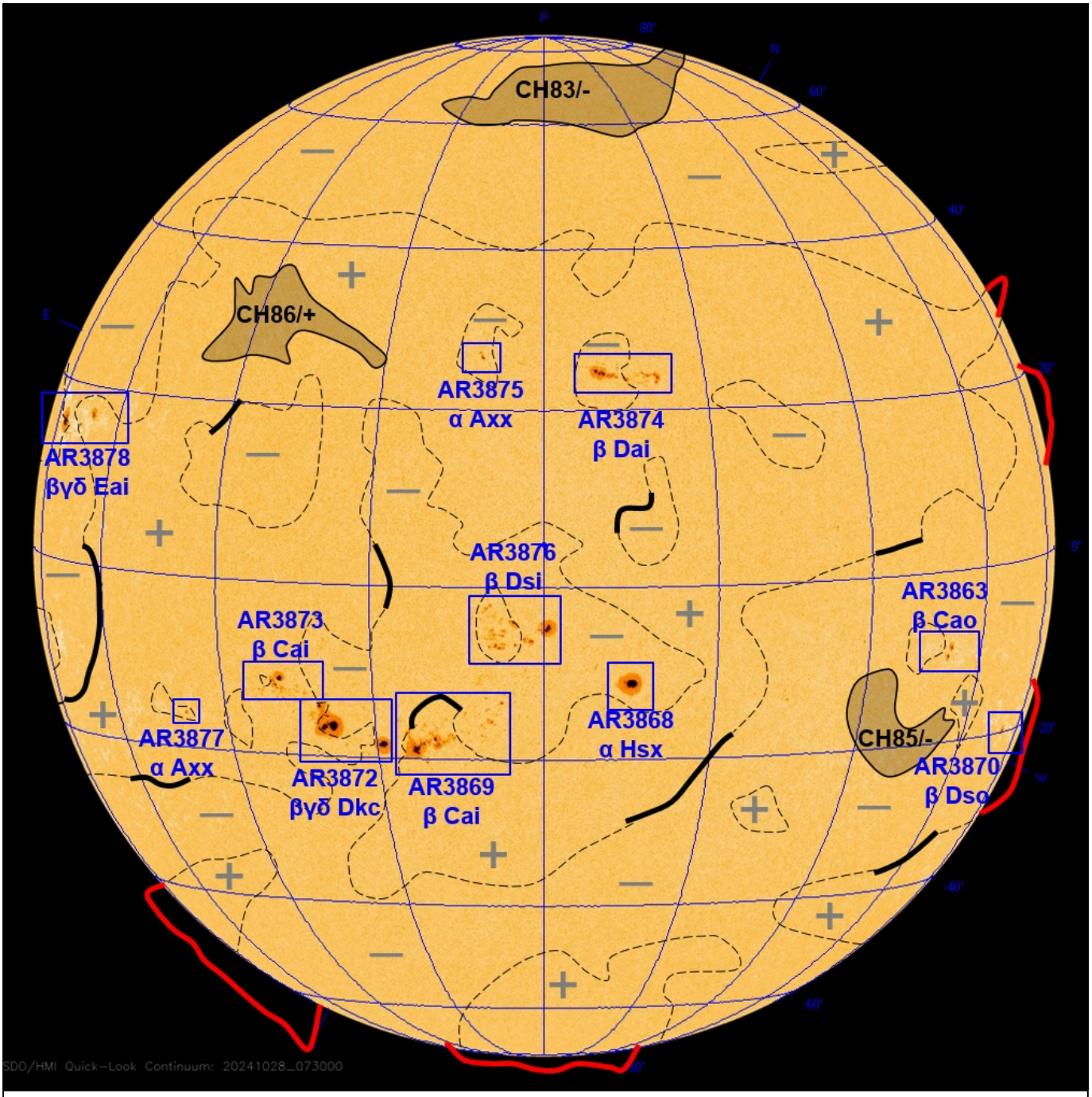
Solar Wind / Geomagnetic Activity: There are no further CME arrivals currently expected. Ongoing CME influence is forecast to ease day 1-2 (28-29 Oct). Solar winds are expected to easing from Elevated to Background, however some influence from the fast wind of CH85 may delay this until day 3 (30 Oct). Geomagnetic activity is forecast to be Quiet to Active at first with a chance of isolated G1 Minor Storm intervals, then easing to be mainly Quiet with isolated Unsettled intervals day 2 (29 Oct) onward.

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 has persisted at S2 Moderate Storm with the weak CME arrival not being sufficient to cause these to drop out. A gradual decay is now expected, but likely persisting above the S1 until at least later day 2, possibly into day 3 (29-30 Aug). Any further notable flares from the regions in the southeast will bring the potential for further enhancement. The high energy electron flux is expected to be mainly Background, with the associated fluence forecast to persist below Active.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1: Solar Synoptic Map 28/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms

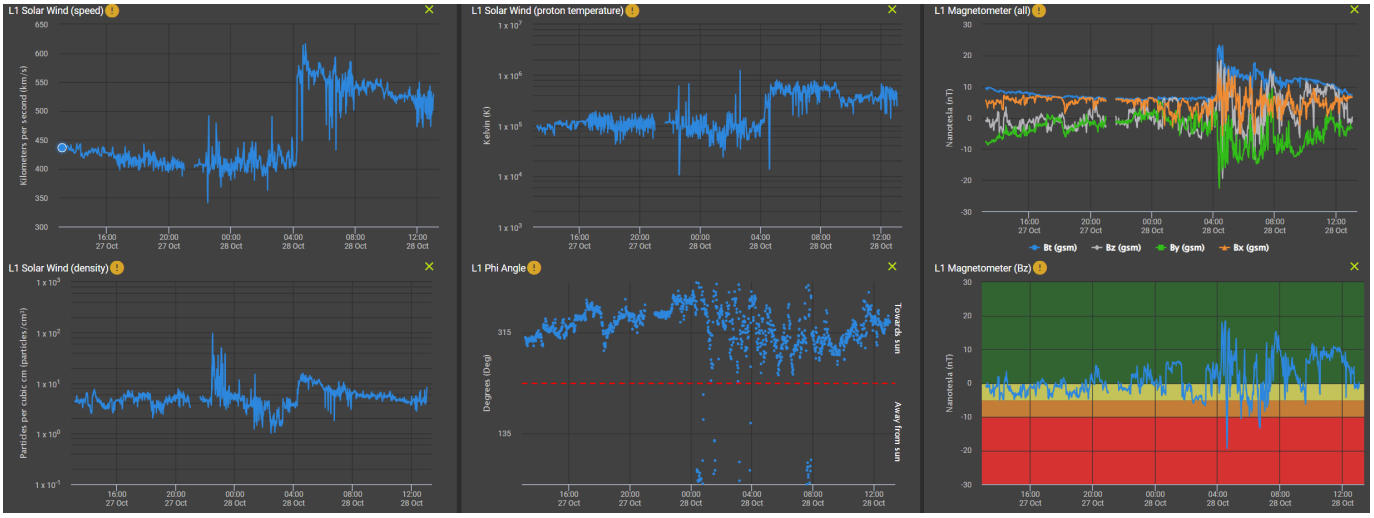
There are currently no Earth-directed CMEs.

Ongoing CME effects, from the arrival of the X1.8 flare early on 28 Oct are expected at first, with elevated solar winds. This CME influence is expected to ease through day 1 and into day 2 (28-29 Oct), however slightly elevated solar winds will potentially continue with a small chance of ongoing enhancement from CH85/-. This is a small and indistinct feature, with any notable enhancement from this low confidence.

Quiet to Active is possible with the ongoing CME influence, with a chance of isolated G1 Minor Storms. This is expected to ease to mainly Quiet with isolated Unsettled spells from day 2 (29 OCt). However, given the location and history of the regions in the southeast disc, any further notable flares from these will have the potential to produce Earth-directed CMEs, and this geomagnetic forecast may change at short notice.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	50	10	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

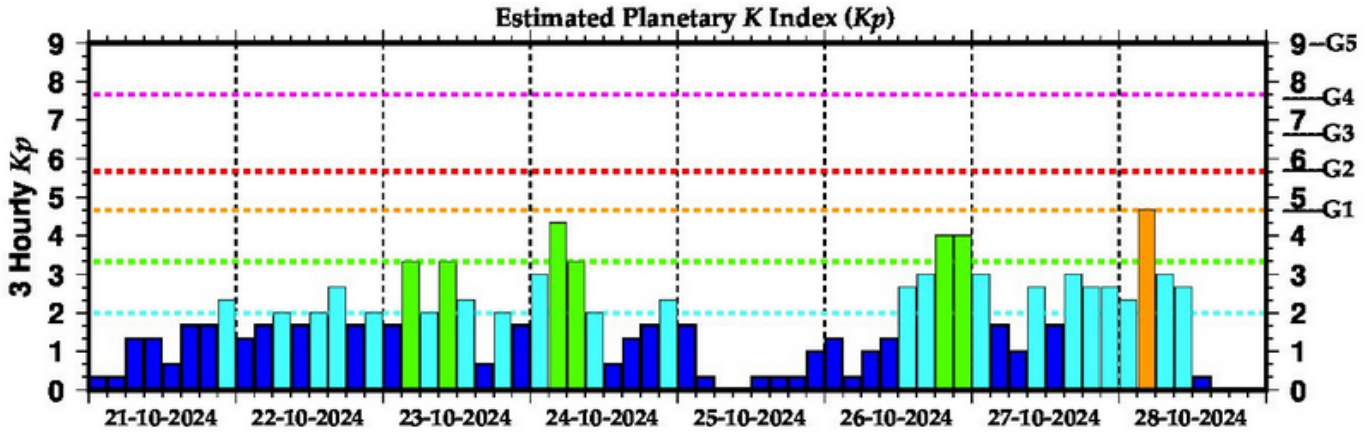
Figure 2: L1 Solar Winds showing clear CME arrival



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 3: BGS Geomagnetic Activity



© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares

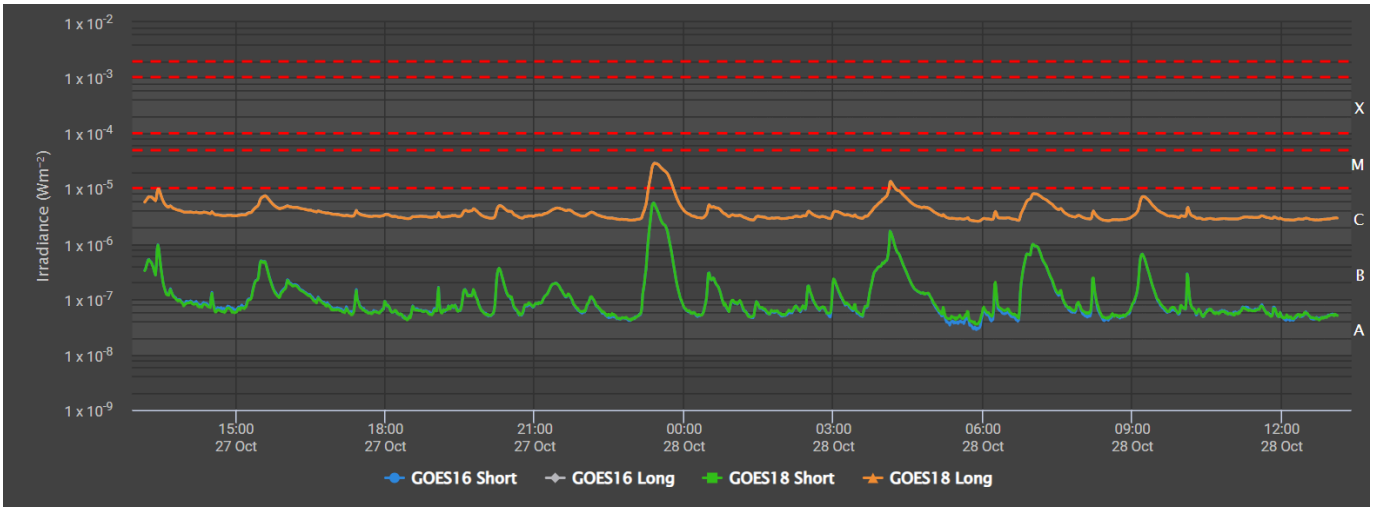
Moderate to High activity is expected, with further M-class flares and a chance of isolated X-class flares, given the complexity and number of regions on the disc.

There are eleven sunspot regions currently on the disc. AR3872 is the most complex, and central of the regions in the relatively congested southeast quadrant, with AR3873 to the east and AR3869 to the west of it. This region has a clear, albeit relatively weak delta spot on the northern edge of its main spot, and this delta-spot is gradually moving west relative to the main trailer, potentially increasing the shear across the region.AR3869 has seen its positive leader spots decay to become a collection of small spots, while AR3873 has seen nearly all positive leader spots fade, aside from one very small one. However, these regions remain complex in terms of their magnetic structure on SDO imagery and have a history of X-class flares.

Elsewhere on the disc, the main flare risk comes from AR3878 near the northeast limb. This is difficult to asses, however the trailer is now showing a likely strong, albeit rather small delta spot. AR3876, now in the south centre disc is also of note, having developed fairly rapidly in the previous 24 hours, but is now showing signs of slowly maturing with some consolidation of its small spots. The other regions are smaller and simpler.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	20	20	20	20

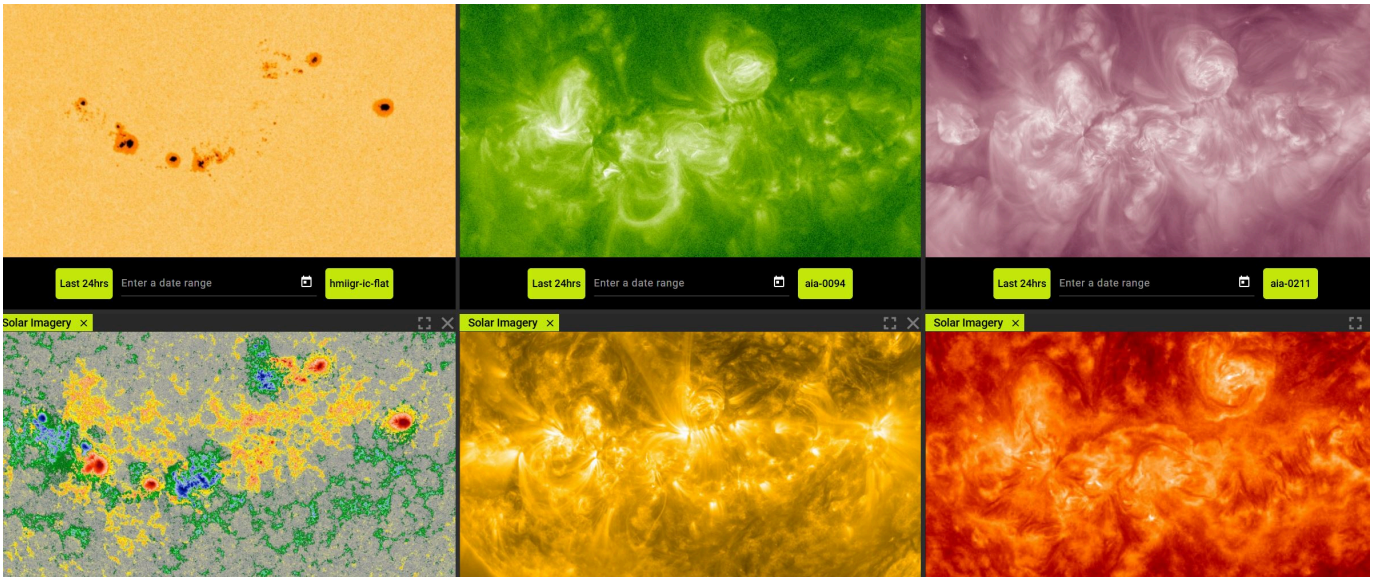
Figure 4: GOES-16/18 X-ray Flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 5: SDO imagery of the southern disc, showing a number of sunspots and complexity.



© Crown Copyright 2024. All Rights Reserved.

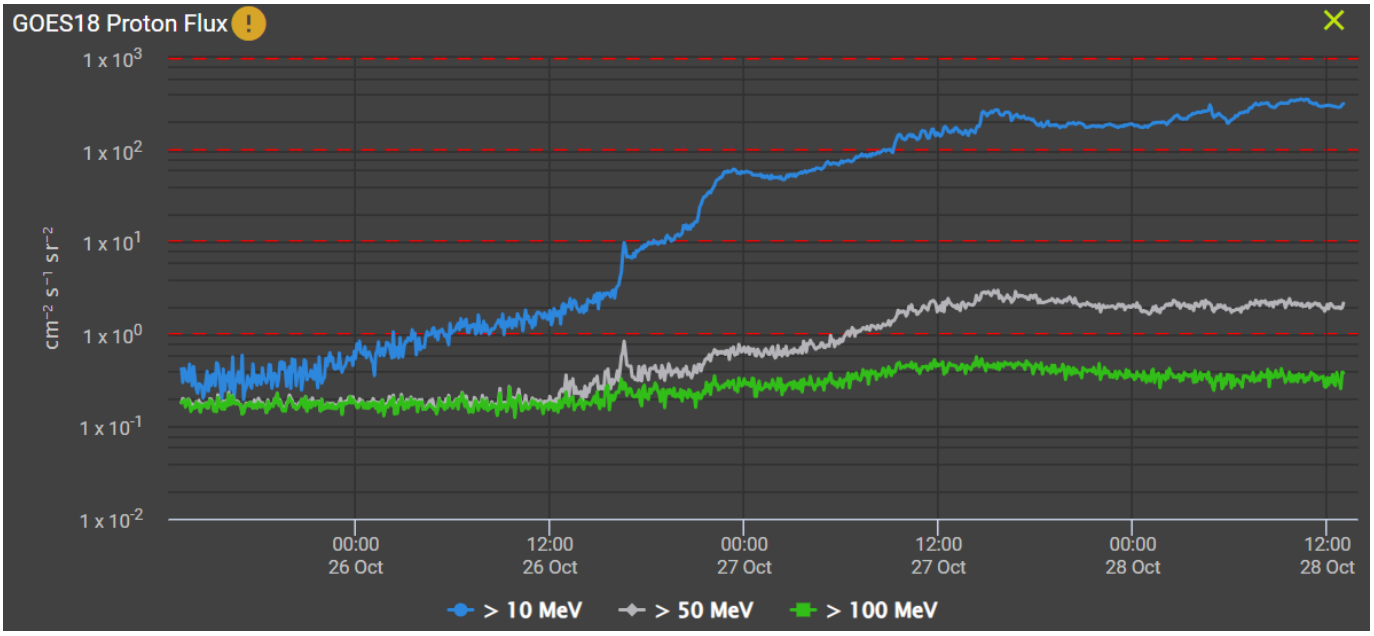
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 has persisted at S2 Moderate Radiation Storm. While the anticipated CME arrival has occurred, this was a weaker than anticipated impact and has not resulted in the subsequent forecast reduction in observed flux. A more gradual decay is now expected, likely persisting above the S1 level at least into day 2, and potentially day 3 (29-30 Oct).

However, given their increasingly geoeffective location and the history of proton productive flares, any further significant flares from the southeast disc has the potential to give further proton enhancement.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	99	80	40	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 6: GOES-18 >10Mev >50MeV and >100 MeV Proton Flux over the last 72 hours.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

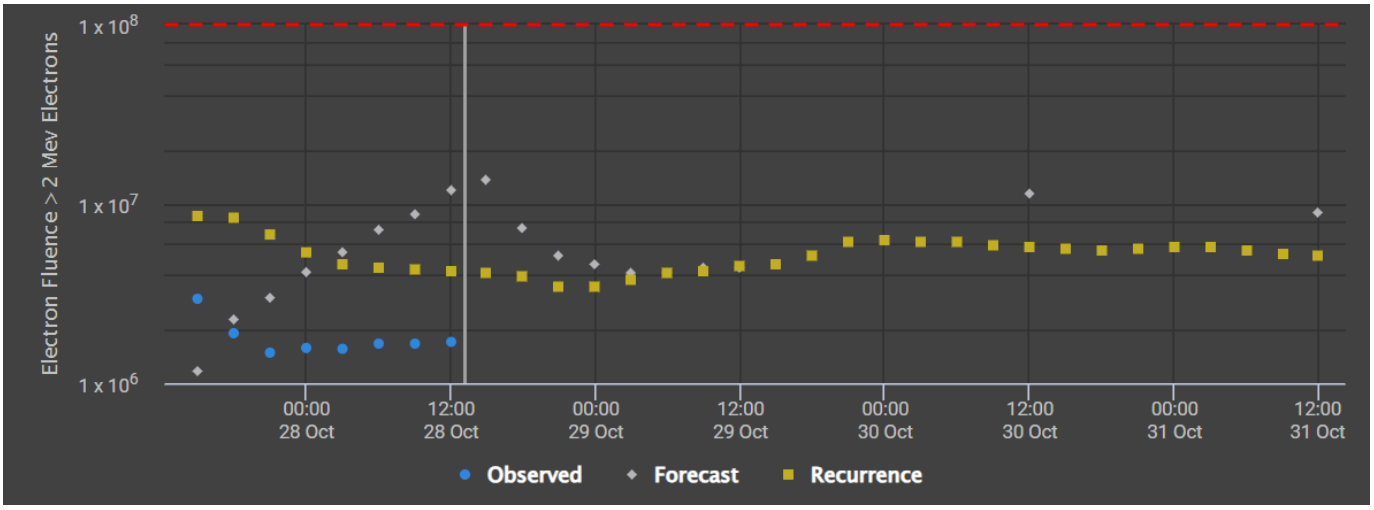
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background and expected to remain at this level. The CME arrival on 27 Oct was weaker than originally anticipated, and any impact on the radiation belts from this is likely to be limited. As solar winds ease, there is chance of for spells of Moderate flux however this is low confidence.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with the MOSWOC REFM forecast though to be providing reasonable guidance to the overall trend, although this is likely to over-estimate the forecast fluence due to the current elevated winds.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 7: GOES-16 >2 MeV 24hr Electron Fluence with REFM and Recurrence.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.